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Climatology of Tibetan Plateau Vortices and connection to upper-level flow in reanalysis data and a high-resolution model simulation

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The Tibetan Plateau (TP) and surrounding high mountain ranges constitute an important forcing of the atmospheric circulation over Asia due to their height and extent. Therefore, the TP impacts weather and climate in downstream regions of East Asia, especially precipitation. Mesoscale Tibetan Plateau Vortices (TPVs) are known to be one of the major precipitation-bearing systems on the TP. They are mainly present at the 500 hPa level and have a vertical extent of 2-3 km while their horizontal scale is around 500 km. Their average lifetime is 18 hours. There are two types of TPVs: the largest number originating and staying on the TP, while a smaller number is able to move off the plateau to the east. The latter category can cause extreme precipitation events and severe flooding in large parts of eastern and southern China downstream of the TP, e.g. the Yangtze River valley.

The first aim of the study is to identify and track TPVs in reanalysis data and to connect the TPV activity to the position and strength of the upper-level subtropical jet stream, and to determine favourable conditions for TPV development and maintenance. We identify and track TPVs using the TRACK algorithm developed by Hodges et al. (1994). Relative vorticity at the 500 hPa level from the ERA-Interim and NCEP-CFSR reanalyses are used as input data. TPVs are retained which originate on the TP and which persist for at least two days, since these are more likely to move off the TP to the East.

The second aim is to identify TPVs in a high-resolution, present-day climate model simulation of the MetOffice Unified Model (UPSCALE, HadGEM3 GA3.0) to assess how well the model represents the TPV climatology and variability.

We find that the reanalysis data sets and the model show similar results for the statistical measures of TPVs (genesis, track, and lysis density). The TPV genesis region is small and stable at a specific region of the TP throughout the year. The reason for this seems to be the convergence of the flow at 500 hPa in the lee of a mountain ridge, which is located directly west of the main genesis region. The strength and position of the subtropical jet stream, shifting from south of the TP in winter to the north in summer, control the distance TPVs can travel eastwards. In the next step we will split the TPVs into two groups, stationary and "moving-off" TPVs, and compare their activity and related atmospheric circulation. Results from these composites may help to answer open research questions on conditions that lead to TPVs moving off the TP, which could help enable better predictions of extreme events in parts of China.